Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Use of Spectrum Bands Above 24 GHz For Mobile Radio Services	)	GN Docket No. 14-177
	)	
Reassessment of Federal Communications Commission Radiofrequency Exposure Limits and Policies	)	ET Docket No. 13-84
	)	
Proposed Changes in the Commission's Rules Regarding Human Exposure to Radiofrequency Electromagnetic Fields	)	ET Docket No. 03-137
	)	
Fostering Innovation and Investment in the Wireless Communications Market	)	GN Docket No. 09-157

COMMENTS OF MARCUS SPECTRUM SOLUTIONS LLC

September 30, 2016

Table of Contents

I. INTRODUCTION

1. These comments focus solely on the "Bands Above 95 GHz" issue contained in para. 442-445 of the R&O&FNPRM in this proceeding. Below we point out several pending issues before the Commission that relate to access by non-federal government licensees to this new block of spectrum and urge FCC action on these issues.

2. While FCC has spectrum allocations up to 275 GHz that follow the ITU Radio Regulations, it has no service rules that go above 95 GHz with the minor exception of two narrow band provisions for amateur radio use and industrial, scientific, and medical (ISM) use. The general issue of how the lack of rules affects technical innovation and the capital formation that is fundamental to such innovation is an issue opened by the Commission in Docket 09-157 that continues to be pending. Both the NOI in that proceeding and several comments address the stifling impact of the lack of service rules for a new technology and the resulting delay, uncertainty, and cost of waiting for Commission action before market access. While a large

multiproduct firm may be able to shift staff to another project while awaiting FCC action, entrepreneurial firms usually don't have such an option and the major cost may not be legal fees but rather staff and overhead costs while being denied income from sales during the pendency of non-routine FCC action.

3. Virtually all of the spectrum allocations above 95 GHz are shared federal government/non-federal government allocations (G/NG)[1]. Much of the spectrum above 95 GHz has either primary or coprimary passive allocations such as radio astronomy, space research (passive), space exploration-satellite (passive), earth exploration-satellite (passive) and some of this spectrum has special protection in the ITU Radio Regulations banning "all emissions"[2]. There is some uncertainty as to how the Commission interprets these provisions particularly for possible telecommunications systems or other system that have near zero interference threat to the primary allocated passive systems.

4. At present the Commission's RF safety regime has quantitative exposure limits up to 100 GHz but a much vaguer requirement above 100 GHz. The long pending rulemaking on RF safety does not propose to adopt any quantitative limits higher than 100 GHz. While this would not prevent use of higher frequencies if the Commission adopts service rules., the lack of a specific safety standards increases regulatory uncertainty for innovators.

5. Marcus Spectrum Solutions LLC (MSS) is the consulting practice of Michael J. Marcus, Sc.D., F-IEEE, a retired FCC senior executive who worked at the Commission nearly 25 years in both the spectrum policy and enforcement areas. His qualifications are well known to

[1] The only exceptions are Amateur Radio Service allocations in 134-141 GHz and 241-250 GHz. Parts of these amateur allocations are secondary to other G and NG allocations and parts are primary. Thus the Amateur Radio Service is now the only group of NG licensees presently with primary access to spectrum above 95 GHz not needing NTIA coordination. Under present allocations all other NG use of this spectrum requires such coordination and the ensuing uncertainties.

[2] Radio Regulation 5.340; In addition Radio Regulation 5.149 urges FCC "urged to take all practicable steps to protect the radio astronomy service from harmful interference." RR 5.340 applies to a total of 35.7 GHz and RR 5.149 applies to a total of 16.8 GHz of the 105 GHz between the present FCC service rule limit and 200 GHz.

the Commission[3]. He was recently awarded the 2013 IEEE Communications Society Award for Award for Public Service in the Field of Telecommunications.[4] He regularly publishes a blog, *SpectrumTalk*[5], that is probably the most comprehensive independent blog on spectrum policy and spectrum reform as well as writing a regular column on spectrum policy issues for *IEEE Wireless Communications Magazine*, published by the IEEE Communications Society, "the premier international forum for the exchange of ideas on communications technologies and information networking"[6]. As an adjunct professor of electrical and computer engineering at Virginia Tech, he teaches a course on spectrum policy for innovative wireless engineers. In 2012-2013 he was chair of IEEE-USA Committee on Communications Policy. These comments do not necessarily represent the view of any client and are being submitted purely in the public interest.

II. SECTION 7 AND DOCKET 13-259 ISSUES

6. Section 7 of the Communications Act of 1934, as amended[7], provides:

> (a) It shall be the policy of the United States to encourage the provision of new technologies and services to the public. Any person or party (other than the Commission) who opposes a new technology or service proposed to be permitted under this chapter shall have the burden to demonstrate that such proposal is inconsistent with the public interest.
> (b) The Commission shall determine whether any new technology or service proposed in a petition or application is in the public interest within one year after such petition or application is filed. If the Commission initiates its own proceeding for a new technology or service, such proceeding shall be completed within 12 months after it is initiated.

7. The Commission has generally avoided citing these provisions in decisions in the nearly 33 years since they were adopted.[8] As far as we know, the Commission has never asked

[3] FCC Press Release "FCC Engineer Michael J. Marcus Honored by Institute of Electrical and Electronics Engineers (IEEE)" February 3, 2004, (http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-243463A1.pdf)

[4] http://www.comsoc.org/about/memberprograms/comsoc-awards/telecom/bios

[5] http://www.marcus-spectrum.com/Blog/Blog.html

[6] http://www.comsoc.org/about/overview

[7] 47 U.S.C. § 157 (Enacted Dec. 8, 1983)

Congress to repeal or to revise the provisions of §7 and they remain as an integral part of the Communications Act.

8. The related provisions of § 303(g), dating from the original 1934 text of the Act,[9] state that the Commission

> "from time to time, as public convenience, interest, or necessity requires, shall … Study new uses for radio, provide for experimental uses of frequencies, and generally encourage the larger and more effective use of radio in the public interest;"

9. Thus it is clear from the text of both section 7 and 303(g) that the statute does not expect the Commission to play a Patent Office-like role of adjudicating on a slow and deliberate pace petitions in its "inbox", but rather to have a proactive role and to respond to "new technologies and services" in a timely way.

10. On July 1, 2013, more than 3 years ago, IEEE-USA[10], the US arm of a transnational engineering society representing the public policy interests of 205,000 US members, filed a *Petition for a Declaratory Ruling*[11] requesting the Commission to

> "issue a declaratory ruling that petitions or applications related to technologies and services in the frequency spectrum above 95 GHz be classified presumptively as new technology or service" in the context of the terms of Section 7 of the Communications Act of 1934, as amended"

11. On October 31, 2013, 4 months later, the Commission requested comments on this petition.[12] Action addressing this petition has been on the Commission's "Items on Circulation" list[13] since January 18, 2016 but no decision has been released to the public.

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[8] The *Policy Statement* in Docket 98-94 (April 2, 1999) is the only example we can find of FCC using Section 7 to justify an action.

[9] Public Law No. 416, June 19, 1934, 73d Congress. (http://www.usc.edu/~douglast/202/lecture20/1934act.html)

[10] http://ieeeusa.org/about/

[11] Docket 13-259, IEEE-USA *Petition for a Declaratory Ruling*, July 1, 2013 (https://ecfsapi.fcc.gov/file/7520955395.pdf)

[12] Public Notice, DA 13-2113, October 31, 2013 and *Erratum* November 1, 2013, (https://apps.fcc.gov/edocs_public/attachmatch/DOC-323836A1.pdf

12. While it would be useful if the Commission received specific proposals for spectrum use above 95 GHz and considered them for a Notice of Proposed Rulemaking, a great stimulus for capital formation for new technology would be a clear policy statement on timely consideration of new technology – possibly in the context of §7. At the very least the Commission should resolve the issue of the long pending Docket 13-259 and clarify how it will deal with such issues.

III. DOCKET 09-157 "INNOVATION NOI" ISSUES

1. On August 27, 2009, more than 7 years ago, the Commission released a *Notice of Inquiry*[14] in Docket 09-157 which has been commonly referred to as the "Innovation NOI". The *NOI* included the following statement

> "(We) are aware that Commission policies and processes can also hinder the progress of innovation and investment. At times, we have seen innovators subjected to lengthy regulatory processes - such as debates over what constitutes harmful interference or how to fit a new spectrum use within our framework of rules - that can be an obstacle to progress in the wireless arena. A goal of this inquiry is to initiate a dialogue with stakeholders on how to remove any unnecessary impediments caused by the Commission's policies and rules."[15]

2. We fully agree that the policies and processes of the Commission have been "an obstacle to progress" in the area above 95 GHz. It is unfortunate that the promised "dialogue with stakeholders promised in the *NOI* has not moved any further. The *status quo* of both no service rules above 95 GHz combined with the demonstrated slow FCC response to private sector initiatives, such the Battelle petition discussed i*nfra*, sends very chilling message to anyone in the private sector considering in investing in R&D above 95 GHz at the same time that our foreign competitor nations are explicitly promoting R&D in this spectrum with both national

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[13] https://transition.fcc.gov/fcc-bin/circ_items.cgi

[14] *Notice of Inquiry*, Docket 09-157, August 27, 2009 (https://apps.fcc.gov/edocs_public/attachmatch/FCC-09-66A1_Rcd.pdf)

[15] *ibid.* at para. 5

government subsidies for R&D as well as coordinated spectrum policy for resulting products and services.

3. Chairman Genachowski wrote in a statement

> "Maximizing and accelerating innovation and investment, along with ensuring competition and empowering consumers, are core components of the FCC's mission. The first inquiry we initiate today focuses on innovation and investment in wireless communications. Specifically, we seek to identify appropriate and concrete steps the Commission can take to support and encourage further innovation and investment in this area, and to understand better the factors that encourage innovation and investment in wireless." (Emphasis added)

4. We filed timely comments in Docket 09-157.[16] In these comments we stated,

> "The Commission does not have to and is not expected to remove all risk from wireless R&D that requires non-routine consideration. But the recent track record has been bizarre. The Commission on its own initiative issued a schedule for resolving the TV white space rulemaking, but then missed that deadline by 2 years! It is clear that much of the IT revolution that has enhanced US economic growth has come from startup firms in areas such as Silicon Valley. It should be clear that such firms as "burning cash" from their investors which they await regulatory approval of new concepts. Endless delays in rulemakings, often with the full encouragement of incumbents who would gladly bleed to death the innovators in prolonged proceedings, discourage innovation by denying it the investment capital that is essential."[17]

5. Similar thoughts on the impact of regulatory delays that are both unpredictable and lengthy are contained in the *pro se* comments of Mitchell Lazarus, a prominent telecommunications lawyer who has specialized in innovative wireless technologies. Mr. Lazarus comments

> "The Commission's Rules are based largely on the technologies in place when they were written. New radio-based technologies often fail to satisfy those rules. The more novel an innovation, the less likely it is to comply. In consequence, a new wireless technology may need a Commission rulemaking or a waiver before it can reach the market. Technical proceedings in general, including those to authorize new technologies, have been dismayingly slow… These delays are an obstacle to innovation. Often a radically new technology comes from a small, privately-funded start-up. Its only product may be

[16] Comments of Marcus Spectrum Solutions LLC, September 14, 2009 (https://ecfsapi.fcc.gov/file/7020039289.pdf)

[17] *ibid.* at p. 4

> the one awaiting Commission approval. These companies may lack the resources to survive a lengthy FCC proceeding." [18]

6. We urge the Commission to consider the record of still pending Docket 09-157 in considering the above 95 GHz aspects of this proceeding. While the FNPRM seemed to seek only specific proposals, there is a cause and effect relationship between the public perception of the FCC's transparency in resolving new technology requests and the availability of private capital to develop such technology to the point that a specific request to FCC is appropriate.

7. The very upper spectrum 5G technology which is the main focus of this docket did not arise spontaneously but was stimulated by FCC action in Docket 94-124 which broke the FCC's longstanding 40 GHz barrier and moved the upper limit of FCC service rules to 64 GHz in 1995. While this 1995 action faced little formal opposition, it also received little support, especially from the major spectrum incumbents at the times. Prof. Theodore Rappaport of NYU Wireless has written

> "(I)t took about ten years for low-cost commercial products to evolve from 1998 (sic) when USA became the first country in the world to authorize low-power 60 GHz operation…(S)hort range wireless networks provided the relevant applications to take advantage of unlicensed 60 GHz spectrum, as well as other frequencies in the mmWave band…Due to the inherent nature of mmWave frequencies … many emerging or future mmWave wireless products and standards (such as 5G mmWave cellular, inter vehicular communications, and backhaul/fronthaul communications standards) are likely to share characteristics with the 60 GHz WPAN/WLAN standards.[19]

8. The Docket 94-124 decision sent the message to the investment community that FCC was receptive to opening up "virgin spectrum" at the upper end of the spectrum and was making an initial block available with great technical flexibility. The resulting spurt of privately funded R&D had an unexpected result: using emerging MIMO technology land mobile communications was practical at frequencies far beyond what had ever been expected! Thus perceptions of FCC

[18] *Comments* of Mitchell Lazarus, Docket 09-157, September 30, 2009 at p. 2-3 (https://ecfsapi.fcc.gov/file/7020039921.pdf)

[19] Theodore Rappaport, *Millimeter Wave Wireless Communications* (2014) Chapter 9

openness have a real impact on technical innovation. (Those of us who are old timers in spectrum policy can recall the "conventional wisdom" of the early 1980s that 1 GHz was the practical upper limit of land mobile communications. The land mobile community only focused on technology above 1 GHz when television broadcasting interests blocked their attempt to have additional sharing of UHF land mobile spectrum.[20])

IV. PENDING FEBRUARY 2014 BATTELLE 102-109.5 GHZ PETITION (RM-11713) ISSUES

9. On February 6, 2014, over 2.5 years ago, Battelle Memorial Institute, Inc. ("Battelle"), through counsel, filed a *Petition for Rulemaking* seeking "service rules to govern fixed use of the 102-109.5 GHz band".[21] The Commission requested public comments[22] on February 24, 2014 but has taken no further action. While Battelle has not been an active participant in FCC proceedings, it is a multibillion dollar entity[23] and was represented in its *Petition for Rulemaking* by a prominent law firm in telecommunications policy.

10. While the Commission has parenthetically mentioned the Battelle *Petition* three times in items in Docket 14-177, it has taken no further action on moving to a rulemaking or dismissing the issue. In the *Notice of Inquiry* in Docket 14-177 on October 17,2014 FCC stated:

> "We recognize that there are also pending proposals relating to fixed use of bands above 24 GHz. See, *e.g.,* Comments of the Fixed Wireless Communications Coalition in Response to Notice of Inquiry, WT Docket No. 10-153 (filed Oct. 5, 2012) (proposing changes to antenna standards for 71-76 and 81-86 GHz bands); Petition for Rulemaking, Battelle Memorial Institute, RM-11713

[20] Joel Brinkley, *Defining Vision: The battle for the future of Television* (1998)

[21] *Petition for Rulemaking*, RM-11713, February 6, 2014 (https://ecfsapi.fcc.gov/file/7521071923.pdf) Marcus Spectrum Solutions LLC was involved in the early drafting of this petition but at this time has no relationship with Battelle or its counsel.

[22] *Public Notice*, Report No. 3000, February 24, 2016 (https://ecfsapi.fcc.gov/file/7521079093.pdf)

[23] http://www.battelle.org/about-us Battelle licensed the patents to the technology of today's ubiquitous "Xerox" technology when it was little more than a laboratory curiosity, produced a practical design for office use, and licensed the technology to the company now named Xerox https://www.xerox.com/downloads/usa/en/s/Storyofxerography.pdf

Battelle also made pioneering inventions in fiber optic technology for wavelength multiplexing.

(filed Feb. 6, 2014) (requesting commencement of proceeding to establish fixed service rules for the 102-109.5 GHz band). For the most part, proposals relating to fixed operation in these bands will be addressed separately."[24]

In the *Notice of Proposed Rulemaking* on October 23, 2015 the Commission stated

"The specific proposal we have before us is Battelle's proposal to establish licensed service rules for the 102-109.5 GHz band. We will consider that proposal in the Wireless Backhaul proceeding, WT Docket No. 10-153. We invite other interested parties to submit other proposals, including proposals for authorizing use under our Part 15 rules."[25]

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12. The most recent proposals issued by the Commission in WT Docket No. 10-153 were in August 3, 2012, well before the filing of the Battelle *Petition*. All of the above facts and dates are on the public record. Any investor doing "due diligence" before investing in a technology above 95 GHz can readily find them. What message do the FCC actions to date on the Battelle *Petition* send to potential investors in upper spectrum technology other than the specific mobile technology below 95 GHz favored by the cellular interests?

13. In recent years there have been nearly continuous discussions before the Commission on the merits of exclusively licensed spectrum versus unlicensed spectrum. The cellular industry in particular has been a strong advocate of exclusive licensing in general.[27] But the physics of

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[24] *Notice of Inquiry*, Docket 14-177, at fn. 64 (October 17, 2014) (https://apps.fcc.gov/edocs_public/attachmatch/FCC-14-154A1_Rcd.pdf)

[25] *Notice of Proposed Rulemaking*, Docket 14-177, at para. 91 (October 23, 2015) (https://apps.fcc.gov/edocs_public/attachmatch/FCC-15-138A1_Rcd.pdf)

[26] *Notice of Proposed Rulemaking*, Docket 14-177, at para. 91 (October 23, 2015) (https://apps.fcc.gov/edocs_public/attachmatch/FCC-15-138A1_Rcd.pdf)

[27] " Just last year, a broad coalition of leaders in the mobile ecosystem … joined CTIA in a call for licensed, exclusive-use spectrum below 3 GHz' -- http://www.ctia.org/docs/default-source/default-document-library/networks.pdf?sfvrsn=0
"Spectrum Frontiers order should license the 28 GHz, 37 GHz, and 39 GHz bands on an exclusive-use, flexible-rights licensed basis, enabling mobile broadband and 5G." -- http://www.ctia.org/docs/default-source/default-document-library/5g-high-band-white-paper.pdf

(continued….)

spectrum above 95 GHz are so different than the physics of radio systems at lower frequencies that the Commission should review the nonbinding recommendation of its Spectrum Policy Task Force (SPTF) in 2002:

> **Millimeterwave bands:** all future rulemaking for terrestrial use above 50 GHz should include *de novo* review of the merits of licensing.[28]

14. While exclusive licensing and unlicensed use at lower bands each have their own merits and constituencies, the basic reasons for and the benefits of licensing that were developed in the dawn of national and international spectrum regulation may not necessarily apply to these upper bands where it is basically much harder to cause unintentional interference than at lower bands. Therefore, we urge the Commission that in future rulemakings consider the SPTF suggestion and not automatically presume exclusive licensing is a preferred solution.

V. PASSIVE USES OF SPECTRUM: ALLOCATIONS AND ITU RADIO REGULATIONS ISSUES

15. Passive allocations exist throughout the radio spectrum. They enable a variety of beneficial scientific observations from radio astronomy to environmental sensing.[29] There is no controversy that such uses of spectrum should be *protected from harmful interference* from signals used for telecommunications and other emissions -- both intentional and unintentional. Passive systems generally have very sensitive receivers that are sometimes very wideband. These need to be protected from even minute traces of radio transmissions.

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[28] Report of Spectrum Policy Task Force, Docket 02-135 , 2002 at p. 63https://apps.fcc.gov/edocs_public/attachmatch/DOC-228542A1.pdf

[29] *Handbook of frequency Allocations and Spectrum Protection for Scientific Uses*, Committee on Radio Frequencies, 2nd Ed.,2015 at p.63 (http://www.nap.edu/catalog/21774/handbook-of-frequency-allocations-and-spectrum-protection-for-scientific-uses)basic

16. The concepts for protecting these passive systems were developed decades ago when the frequencies of interest were much lower than the 95+ GHz that is the focus of FCC's proposals here. Some of these concepts are appropriate for lower bands but may be excessively burdensome at higher bands *with no net benefit for the actual use of passive systems*.

17. The difference between lower spectrum and upper spectrum and how it affects protection of passive systems is discussed in Report ITU-R RA.2189[30]. This report addresses the case of radio astronomy – but not necessarily other passive sensors:

> "Certain characteristics of the frequency range 275-3 000 GHz combine to reduce the likelihood of interference between the radio astronomy service and active services in this range. The purpose of this Report is to present a basic introduction to those characteristics and how they affect potential sharing scenarios. Based on the analysis in this Report, there is little chance for interference to radio telescopes from co-frequency terrestrial, airborne, or satellite transmitters."

18. The above 95 GHz virgin spectrum at issue in this rulemaking is not exactly the same as the 275-3000 GHz spectrum reviewed in this ITU-R report, but it is closely related in physical characteristics and *both* are very different than spectrum below 3 GHz where most concepts of spectrum management were developed in past decades. So while it may makes sense in lower spectrum to ban ALL emissions from certain passive bands because reasonable antennas sizes cannot reliably focus all energy away from passive sensors and propagation allows both long distance propagation and intermittent/anomalous propagation modes, *e.g.* ducting[31], at even longer distances, this concept should not be automatically ported to higher spectrum where the physics is quite different.

19. The physical phenomenon of radio propagation and the nature of antennas of reasonable size that can be built differs greatly between the spectrum above 95 GHz and the

[30] ITU, "Sharing between the radio astronomy service and active services in the frequency range 275-3 000 GHz", Report ITU-R RA.2189 (2010) (http://www.itu.int/pub/publications.aspx?lang=en&parent=R-REP-RA.2189-2010)

[31] http://www.radartutorial.eu/07.waves/wa17.en.html

spectrum below 10 GHz. Propagation law above 95 GHz is dominated not by geometric spreading and multipath, but by atmospheric absorption as described in a 1997 FCC publication.[32] This publication states in its introduction,

> Planning for millimeter wave spectrum use must take into account the propagation characteristics of radio signals at this frequency range. While signals at lower frequency bands can propagate for many miles and penetrate more easily through buildings, millimeter wave signals can travel only a few miles or less and do not penetrate solid materials very well.

20. ITU-R RA.2189 addresses the specific case of radio astronomy above 275 GHz which differs from environmental sensing in several key details. But the physics of propagation and antennas size at above 275 GHz are not that different than the corresponding issues at 95-275 GHz. Radio astronomy antennas are ground based systems that point towards the sky. In particular in bands above 95 GHz atmospheric absorption limits the capability of low altitude antennas in areas with moderate to high humidity levels so most, if not all observations in the US are done at 2 mountaintop installations in Arizona, one in California, and one in Hawaii. While in theory a radio astronomy installation in West Virginia and one in Massachusetts cover above 95 GHz, it is questionable how much they are used at the upper end of their coverage due to climate issues.

21. Environmental sensing could be at low altitudes although it is more commonly satellite based. Satellite based sensors do not necessarily need to have zero emissions in their bandwidth if *de minimis* ground based radio power reaches the satellite antenna due to pointing differences and off axis rejection by the antenna.

22. Since the 1970s and the original adoption of Part 25 there has been successful fixed/terrestrial fixed sharing using careful coordination between the frequencies and directions

[32] FCC, Millimeter Wave Propagation: Spectrum Management Implications, OET Bulletin No. 70 (July 1997) (https://www.fcc.gov/bureaus/oet/info/documents/bulletins/oet70/oet70a.pdf)

of terrestrial antennas and geostationary orbit (GSO) satellites. More recently non-geostationary (NGSO) satellite orbit systems have shared spectrum with GSO systems by changing their spectrum use before a predicted alignment event that might have resulted in interference to the GSO system.[33] The same basic techniques could be used to share terrestrial use of 95+ GHz with passive systems and would be more effective than at lower bands due to the smaller antenna beam width at the upper end of the spectrum as well as the increased atmospheric absorption. Such absorption varies with elevation angle and altitude and is lower at zenith. But terrestrial telecommunications systems do not need zenith transmissions, rather their transmissions are usually at low elevation angles to other sites and low angle paths maximize atmospheric absorption.

23. A major difference between spectrum regulation above 95 GHz and lower bands is the high density of allocation for passive services compared to lower bands. While only one of the block of 83 channels originally used for VHF and UHF TV broadcasting or 1.2%, was set aside for a passive use ("TV channel 37" = 608-614 MHz). In 1-2 GHz, only 1160.5-1168.4 MHz (7.9 MHz bandwidth) has a primary passive allocation or 0.79 % of the total 1 GHz bandwidth. But in the "next frontier" of spectrum use in 95-200 GHz the density of passive allocations is much higher. The underlying physical reason for this is that radio astronomy and environmental sensing spectrum needs generally result from frequencies where various molecules have resonances and there are more in the upper spectrum than in lower spectrum.[34]

[33] *See* 47 C.F.R. § 25.258 for an example

[34] Recommendation ITU-R RS.515-5 (2012) "Frequency bands and bandwidths used for satellite passive remote sensing" (http://www.itu.int/dms_pubrec/itu-r/rec/rs/R-REC-RS.515-5-201208-I!!PDF-E.pdf

24. This high density of passive allocations above 95 GHz and their regulatory protection is shown in the table below

Category of Passive Protection	Total Such Spectrum in 95-200 GHz (GHz)	Fraction of Band with Protection
Primary Passive Allocation	16.85	16%
Coprimary Passive Allocation	53.9	51%
Protection under RR 5.149	35.7	34%
Protection under RR 5.340	16.85	16%
Protection under US 246	16.85	16%

Table I: Passive bandwidth and its present regulatory protection in 95-200 GHz

25. The first and second lines of the table show US domestic passive primary and coprimary allocations in the 95-200 GHz band.[35] Virtually all new allocations and service rules in above 95 GHz need coordination with NTIA under the terms of the FCC's Memorandum of Understanding[36] with that agency since the spectrum is G/NG shared with a few minor exceptions. Coordinating FCC rule changes in passive primary or coprimary bands is particularly complex as the three agencies with active passive programs are very protective.

26. Radio Regulation (RR) 5.149 is a provision that says "administrations" – national spectrum regulators like FCC and NTIA – "are urged to take all practicable steps to protect the radio astronomy service from harmful interference" in a group of bands, 13 of which are in 95-200 GHz. RR 5.340 goes further and states that "(a)ll emissions are prohibited" in a group of bands that includes 7 bands in 95-200 GHz. Allocation table footnote US246 is a provision previously agreed to by FCC and NTIA that states "No station shall be authorized to transmit in" certain bands that duplicate the list in RR 5.340 .

[35] The "Coprimary Passive Allocation" line may underestimate the issue here as it includes 174.8-182 GHz where inter-satellite links are the only allowed transmission. Thus this band has no terrestrial allocations. 136-141 GHz is also counted in this category even though the only terrestrial allocation is for Amateur Radio Service and that is secondary.

[36] https://apps.fcc.gov/edocs_public/attachmatch/DOC-230835A2.pdf

27. Presumably the provisions of RR 5.149 and 5.340 are subordinate to the more general provisions of RR 4.4[37] which allow FCC to make noncompliant domestic allocation *if* they do not impact other ITU signatories or are agreed to by them. FCC previously used this provision to create service rules in the ITU Region II Radio Astronomy allocation in 608-614 MHz ("TV channel 37") with carefully crafted rules[38] that protect the primary passive allocation while allowing wireless medical telemetry devices in certain limited locations.

28. We note however, from recent discussions in US IWP-7D, a preparatory group for ITU-R that there is a perception in that group among US passive spectrum users that RR 4.4 has been effectively modified by the ITU Radio Regulations Board (RRB) Rules of Procedure (2012) so that in case of an action that is in conflict with RR 5.340 but justified under RR 4.4 RRB

> "…considers that, in view of this prohibition, a notification concerning any other use than those authorized in the band or on the frequencies concerned cannot be accepted even with a reference to No. **4.4**; furthermore the administration submitting such a notice is urged to abstain from such usage."

29. Thus FCC should clarify what its current position is with respect to RR 4.4 on making allocations inconsistent with ITU allocations in bands under conditions that pose no interference risk to users of the ITU allocations in other countries or even in the US. At lower frequencies RR 4.4 is of much less practical value than at 95+ GHz where propagation and antenna directionality allow careful control of possible harmful inter-service interference. We believe that RR 4.4 can be used by the Commission to craft rules in the above 95 GHz area for terrestrial

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[37] "Administrations of the Member States shall not assign to a station any frequency in derogation of either the Table of Frequency Allocations in this Chapter or the other provisions of these Regulations, except on the express condition that such a station, when using such a frequency assignment, shall not cause harmful interference to, and shall not claim protection from harmful interference caused by, a station operating in accordance with the provisions of the Constitution, the Convention and these Regulations." - http://www.itu.int/dms_pub/itu-s/oth/02/02/S02020000244501PDFE.PDF

[38] 47 C.F.R. § 95.1119

systems to coexist with passive allocations provided care is taken to prevent inter-service interference.

30. If one examines the primary and coprimary passive allocations in 95-200 GHz, the only blocks without such allocations are shown below:

Frequency Band	Bandwidth
122.25-130 GHz	7.75 GHz
158.5-164 GHz	5.5 GHz
167-174.8 GHz	7.8 GHz
191.8-200 GHz	8.2 GHz

Table II: Bands in 95-200 GHz without passive primary of coprimary allocation

31. Thus even though there are 105 GHz of bandwidth between 95 and 200 GHz the present passive primary and coprimary allocations chop this up into smaller pieces, the largest of which is 8.2 GHz if excessive protection is applied to passive services. If one assumes that NTIA and the IRAC membership will allow use of bands with coprimary fixed allocation by adopting reasonable coordination procedures based only on actual interference concerns, then fixed service could use all the allocations where it is coprimary and which are between bands protected

by US246 and RR 5.340. Table III below shows where such bands are. It can be seen that the largest such block with Fixed service coprimary status is 12.5 GHz wide

Coprimary Fixed Service Block Between US246/RR 5.340 Blocks	Bandwidth Available
95-100 GHz	5 GHz
102-109.5 GHz	7.5 GHz
111.8-114.25 GHz	2.45 GHz
122.5-123 GHz	0.5 GHz
130-134 GHz	4 GHz
141-148.5 GHz	7.5 GHz
151.5-164 GHz	12.5 GHz
167-174.8 GHz	7.8 GHz
191.8-200 GHz	8.2 GHz

Table III: Coprimary Fixed Service Block Between US246/RR 5.340 Blocks

32. The goal should be strict protection of passive services from harmful interference. In bands listed in RR 5.340 and US 246 this should be total protection but that does not necessarily mean no emissions of any other service *if* means can be found to assure interference-free sharing. While at lower bands such sharing may be impossible with high confidence, the physics of these frequencies gives new sharing options. In bands list in RR 5.149 the test should be protection using "all practicable steps".

33. FCC should clarify what its current position is with respect to RR 4.4 on making allocations inconsistent with ITU allocations in bands under conditions that pose no interference risk to users of the ITU allocations in other countries or even in the US. At lower frequencies RR 4.4 is of much less practical value than at 95+ GHz where propagation and antenna directionality allow careful control of possible harmful inter-service interference. We believe that RR 4.4 can be used by the Commission to craft rules in the above 95 GHz area for terrestrial systems to coexistence with passive allocations provided care is taken to prevent inter-service interference.

VI. NTIA COORDINATION ISSUES

34. With minor exceptions all spectrum above 95 GHz is shared G/NG spectrum and thus domestic allocations and service rules are subject to the previously mentioned NTIA/FCC Memorandum of Understanding. In addition, the agencies that fund passive scientific research are well represented in the Interdepartmental Radio Advisory Committee (IRAC) and effectively advocate for what they perceive as their interests.

35. The chronology of FCC Experimental License Application File 1047-EX-ST-2014 is on the public record as is an indication of coordination problems between FCC and NTIA on spectrum above 95 GHz. This military-sponsored R&D proposed a brief test in Ohio of an initial test version of a high speed data link at 95-105 GHz.[39] This would have overlapped the band at 10-102 GHz that is protected by US246 and RR 5.340. Even though this short terrestrial test posed no interference threat any operational passive system it was rejected by NTIA based on input from an IRAC member agency which we shall call "Agency Y". (It appears that in experimental license reviews NTIA normally depend on unanimity in the IRAC subcommittee that reviews applications so one agency may be able to effectively veto an application without additional review from NTIA.) In a later exchange with a representative of Agency Y we received the following message:

> "It is (Agency Y) policy to not allow ANY emissions in ANY bands allocated to exclusive passive use such as given in US246 and RR No. 5.340. For this reason I had no choice but to object to the subject application. In fact, had (the sponsoring military agency) applied for the STA through one of the MILDEPS, (Agency Y) would have objected to that as well."

36. Only after several more weeks of an IRAC member representing the sponsoring agency pressing Agency Y did that Agency Y relent and allow NTIA to allow FCC to authorize

[39] This specific band was of no long term interest to the developers and sponsors of this experiment. The only reason it was proposed for a first test of a novel radio modulation technique was that there was a production semiconductor amplifier that operated at this frequency that had the proper parameters for the test. A custom made amplifier at another frequency would have cost millions of dollars to produce and would have been useless if the modulation was shown to be ineffective in the test.

this test. NTIA staff apparently was unwilling to override the objections of Agency Y and focused on achieving consensus to resolve the matter. Agency Y was not concerned here about *actual interference* to any operational passive system, it was focused only on precedent issues that are not actually precedents. If this is the type of treatment that private sector military-sponsored research gets in NTIA coordination, imagine the investment community's view of how purely private sector R&D will be treated? We want to encourage private sector R&D to further the goals of §§7, 303(g).

37. So while NTIA is expected to advocate on behalf of passive radio programs funded or operated by IRAC members, FCC should review with NTIA past actions above 95 GHz to see whether they meet the statutory guidance of both agencies. We hope that then new language of §5.85(a)(2)[40], based, in part, on a proposal in our *Petition for Reconsideration*[41], will avoid this issue in the future. We urge FCC leadership to discuss this issue with NTIA leadership to make sure there is no misunderstanding on this issue. NTIA appears to be included in the "(a)ny person or party (other than the Commission) who opposes a new technology or service" provision of §7(a) and thus appears to have a "burden of proof" test more than the poorly articulated concerns of an IRAC member to face in refusing to coordinate on an experimental license for a new technology.

38. NTIA exercises under delegated authority the President's § 305[42] control over use of spectrum by federal entities. But its mission is broader and § 901[43] provides that **"**The NTIA

[40] "Applications to use any frequency or frequency band exclusively allocated to the passive services (including the radio astronomy service) must include an explicit justification of why nearby bands that have non-passive allocations are not adequate for the experiment. Such applications must also state that the applicant acknowledges that long term or multiple location use of passive bands is not possible and that the applicant intends to transition any long-term use to a band with appropriate allocations." – 47 C.F.R §5.85(a)(2)

[41] *Petition for Reconsideration* of Marcus Spectrum Solutions LLC, Docket 10-236, May 22, 2013 at p, 13 (https://ecfsapi.fcc.gov/file/7022416291.pdf)

[42] 47 U.S.C. § 305

shall seek to advance the following policies: …Promoting the benefits of technological development in the United States for all users of telecommunications and information facilities." (emphasis added.)

39. So while NTIA is expected to advocate on behalf of passive radio programs funded or operated by IRAC members, FCC should work with NTIA to assure that win/win sharing solutions between active systems and passive systems are objectively considered in the spectrum above 95 GHz and that we just don't recycle passive protection strategies of a different era that we developed for much lower spectrum with different physical characteristics.

VII. DOCKET 13-84 AND RF SAFETY ISSUES

40. This proceeding was initiated in a R&O in Docket 03-137 and FNPRM&NOI in the new docket released on March 29, 2013. The proposed rules in this proceeding update existing FCC RF safety rules. But the proposed rules retain the upper limit for specific safety levels in §1.1307(b) and § 1.1310(e) of "100,000 MHz" or 100 GHz. While it is clear that transmitters at high frequencies may not endanger the public or employees of licensees the lack of a specific limit creates a real regulatory uncertainty for users of upper spectrum: what specific limit will FCC hold them accountable for and will local jurisdictions in the absence of any quantitative FCC limit adopt an overly restrictive limit. Today FCC licensees routine argue federal preemption over local regulation of RF safety, but such an argument would be much harder if FCC lacked a specific limit.

41. Note that the current limit of 100 GHz has been in place for years and is 5 GHz higher than the highest FCC radio service rule. The existing standard is based on Section 4.2 of "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz," ANSI/IEEE Std C95.1 (1992). As the title indicates

(Continued from previous page)

[43] 47 U.S.C. § 901

this standard goes up to 300 GHz and thus could be the basis of an extension of the FCC quantitative limit. We urge the Commission to extend the upper quantitative RF safety limits to at least 200 GHz by action in either Docket 13-84 or by an *NPRM* that deals with service rules above 95 GHz.

VIII. NEED FOR A LARGE CONTIGUOUS FIXED SERVICE BLOCK

42. In Tables II and III above we have shown that under present domestic allocation the bandwidth available in a contiguous block spectrum is severely limited by passive allocations and regulations adopted to protect them. The largest block for fixed without covering a coprimary passive allocation and thus requiring coordination that has at time been contentious in the past is 191.8-200 GHz with a bandwidth of 8.2 GHz. A slightly small block at 122.25-130 GHz has a bandwidth 7.75 GHz and is less of a jump from present technology. If NTIA is fully cooperative on coordinating fixed service licenses above 95 GHz based solely on actual interference to passive systems then the 12.5 GHz bandwidth in 151.5-164 GHz would be available. But one can not achieve more than 12.5 GHz of bandwidth without impinging on bands with protection under RR 4.340 and US246 which both forbid all emissions in certain bands regardless of their interference potential – PERIOD!

43. While the block sizes of 8-12 GHz may seem to be a large bandwidth, it is not large if one wants to build a radio alternative for fiber optics for special cases where fiber installation costs are very high (as in heavily urbanized areas) or for rapid restoration of cellular backhaul or other wideband "pipes" after a widespread disaster when fiber cannot be installed promptly or in special cases when latency (time delay) is an issue.[44]

[44] The speed of light is 20-30% slower in the glass used in fiber optics than in air and thus information travels faster on radio signals than in fiber optics although in most applications the delay is not important.

44. The DARPA 100G program[45] is an ongoing military R&D program to develop bandwidths greater than 100 Gb/s. While the focus of this program is air-to-air and air-to ground data links, the same technology is application for terrestrial transmission although the distances covered will be less due to propagation issues.

45. Military R&D is not the only interest in high speed transmissions above 95 GHz. Figure 3 below shows data from a recently published article on progress on millimeterwave and terahertz transmissions systems around the world:

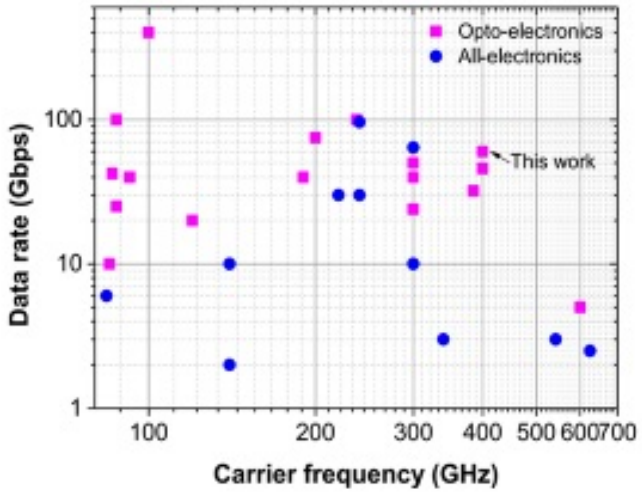


Figure 3: Published summary of results for millimeterwave and terahertz transmissions systems[46]

46. There are strong indications that other countries' spectrum regulators do not have the same rigid interpretation of RR 5.149 and RR 5.340 as NTIA has and are allowing fixed systems if they do not impact actual passive systems. In addition spectrum regulators and industrial policy gencies in other countries are actively supporting R&D funding for research above 95

[45] http://www.darpa.mil/program/100-gb-s-rf-backbone

[46] Yu, Asif, *et al.*, "400-GHz Wireless Transmission of 60-Gb/s Nyquist-QPSK Signals Using UTC-PD and Heterodyne Mixer," *IEEE Transactions on Terahertz Science and Technology*, Issue No. 99, p. 1-6 (August 2016) (http://ieeexplore.ieee.org/document/7556985/)

GHz in an effort to improve *their* national competitiveness.[47] Wide bandwidth blocks allow wide "pipes" for applications such as cellular backhaul and broadband services to homes and businesses in certain limited locations where fiber optics is not economical. They also facilitate recovery of telecommunications systems from large scale disasters where fiber optic systems can not be replaced in a timely way.

47. We urge the Commission to work with NTIA to develop an understanding for protecting with certainty actual passive uses above 95 GHz while enabling overlapping terrestrial fixed service with bandwidths in excess of 20 GHz. This is necessary to maintain national competitiveness in upper spectrum technology as well as to give our telecommunications networks the tools to handle special situations where fiber optics is not viable.

IX. TERAHERTZ SPECTROSCOPY AND RELATED USES

48. Terahertz spectroscopy is an emerging short range non-communications radio technology that uses spectrum above 95 GHz and in some cases also spectrum somewhat below that limit. On Wikipedia, terahertz spectroscopy is defined in a section that has been present there since 2013 as

> "Terahertz spectroscopy detects and controls properties of matter with electromagnetic fields that are in the frequency range between a few hundred gigahertz and several terahertz (abbreviated as THz). In many-body systems, several of the relevant states have an energy difference that matches with the energy of a THz photon. Therefore, THz spectroscopy provides a particularly powerful method in resolving and controlling individual transitions between different many-body states. By doing this, one gains new insights about many-body quantum kinetics and how that can be utilized in developing new technologies that are optimized up to the elementary quantum level."[48]

49. Terahertz spectroscopy equipment is now manufactured and sold – and presumably used by both federal and nonfederal entities - in the US as well as other countries as can be

[47] Comments of NYU Wireless, Docket 14-177, at p. 8-14 (January 13, 2015) (https://ecfsapi.fcc.gov/file/60001013322.pdf)

[48] https://en.wikipedia.org/wiki/Terahertz_spectroscopy_and_technology

readily confirmed by a Google search. Because FCC has no specific rules for this type of equipment we believe the sale of this equipment does not violate the marketing rules of § 2.803. However, the use of such equipment would appear to violate §301 of the Communications Act.

50. According to one US manufacturer[49], such equipment has the following applications:

Aircraft Non-destructive Testing
Examination of Packaged Goods
Spacecraft Non-destructive Testing
Radome Inspection
Pipeline Repair Inspection

51. A 2009 presentation from the United Kingdom's National Physics Laboratory[50] discusses how terahertz spectroscopy can be used for study of:

Polymers
Semiconductors
Ceramics and glasses
Organic molecules
Gas spectroscopy
Conductive films
Liquid crystals
Composites
Oils
Nondestructive testing

52. Some applications of terahertz spectroscopy for electronic materials research., such as those sold by Lake Shore Cryotronics[51], have to be performed over a wide range of temperatures of the material samples being tested and are usually done inside a sealed metal chamber with no emissions into the environment and thus, presumably, are not subject to potential FCC regulation. But other systems, such as the "Picometrix T-Gauge® Sensor[52]" are used in

[49] [49] http://advancedphotonix.com/thzsolutions/markets/qcndt/

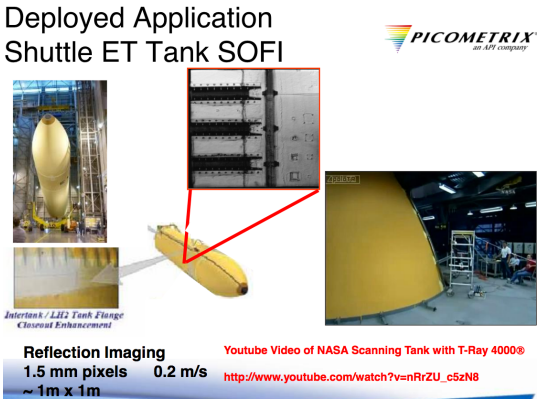
[50] http://www.npl.co.uk/upload/pdf/091217_terahertz_naftaly.pdf

[51] http://www.lakeshore.com/products/THz-System/Pages/overview.aspx
https://youtu.be/KaWlyeoM9uY is a video showing this technology in operation

[52] http://lunainc.com/thz/markets/quality_control

applications including factory production lines for real-time quality control of materials being produced[53] and are not readily or economically shielded from the environment.

53. It is ironic that we expect any FCC action to remove regulatory ambiguities will likely be opposed by NASA – the most ardent defender of passive spectrum in the US – because much of the technology was actually developed with NASA funding for rocket engine insulation and Space Shuttle tile inspection and verification after the *Challenger* tragedy. Thus some of the commercial units now sold are technology transfer from this NASA program. Figures 1 and 2 show NASA's own uses of this technology.[54] Generally NASA is very proud of such technology spinoff from their taxpayer supported R&D and its impact on the economy.[55] We hope that NASA spectrum staff considers the positive aspects of such technology transfer along with its *de minimis* interference risk before pressing NTIA for an overly rigid interpretation of US 246 and RR 5.340 in FCC coordination.



[53] *See* https://youtu.be/fqHhFW2Hjc4 for an interview of the CEO of the original developer of this technology discussing the applications of this technology and showing it in operation.

[54] http://www.nasa.gov/sites/default/files/626494main_3-3-A_Zimdars.pdf

[55] https://spinoff.nasa.gov/
https://spinoff.nasa.gov/Spinoff2008/tech_benefits.html
http://www.nasa.gov/offices/oct/techtransfer

Figure 1: NASA Terahertz spectroscopy application in examining Space Shuttle rocket engine insulation[56]

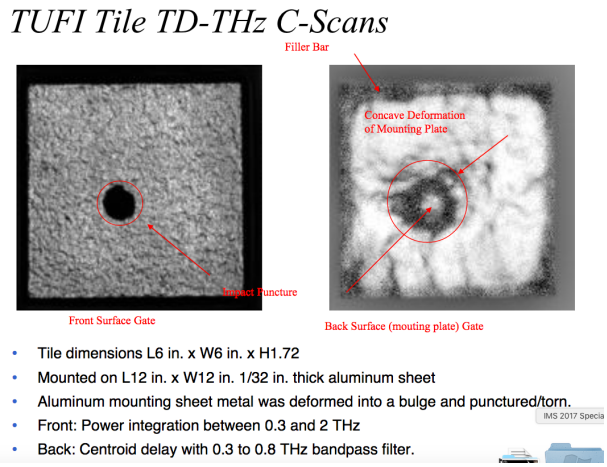


Figure 2: Terahertz spectroscopy application in examining Space Shuttle tiles (TUFI)[57]

54. While the US manufacturers and users of this equipment have quietly existed in a regulatory vacuum for years, perhaps like UWB ground penetrating radars before the UWB rulemaking, there is real concern that if they need additional capital for R&D or manufacturing expansion that an investor doing due diligence might discover the regulatory ambiguity these products are in. Or perhaps an overzealous proponent of passive spectrum use might demand FCC enforce a literal strict interpretation of RR 5.340 and the resulting controversy might dry up funding for such firms just as the pendency of Docket 10-4 dried up funding for US manufacturers of "cellular boosters".

55. Terahertz spectroscopy has two basic versions with different utility for different application. "Time domain" terahertz spectroscopy involved a very narrow pulse such as shown in this figure from a NASA presentation:

[56] http://www.nasa.gov/sites/default/files/626494main_3-3-A_Zimdars.pdf

[57] *ibid.*

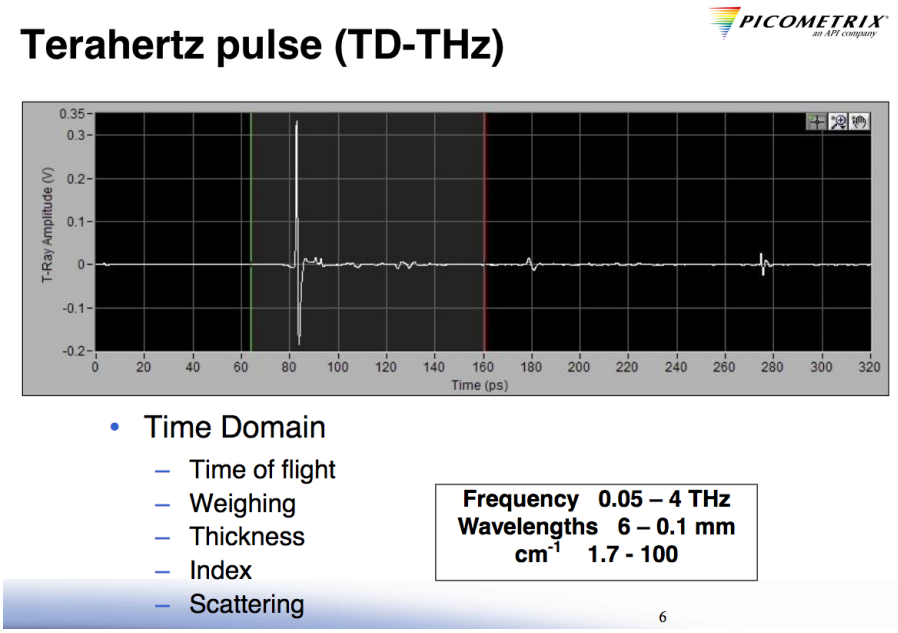


Figure 3:Time domain terahertz spectroscopy pulse

56. The picosecond pulse in Figure 3 has a bandwidth that covers from 50 GHz to 4 THz that thus overlaps with bands protected by US246, RR 5.340, and RR 5.149. However the power of such emissions is negligible and if used indoors the outdoor emissions are almost certainly undetectable as most building materials are opaque at these frequencies and atmospheric attenuation is also large. Typical powers for such emissions are less than 1 microwatt and are focused on the object being tested.

57. "Frequency domain" terahertz spectroscopy uses a signal generator that sweeps in frequency over time like a radar chirp. Since amplifiers are often used the power can be higher but the frequency range is more limited and depends on the application. 100 mW amplifiers are now commercially available at mmW/THz frequencies and could be used in such a system. But as in the time domain case, use is usually indoors with outdoor emissions expected to be undetectable. In theory frequency domain systems could notch out certain bands with some resulting impact on capability while such notching is not practical for time domain systems.

58. We urge the Commission to initiate a rulemaking to legitimize the use terahertz spectroscopy technology systems and remove the threat of investment delays resulting from

regulatory uncertainty in order to maintain US competitiveness in this emerging technology. We believe that Part 18 may be a good home for such rules. §18.107(c) defines Industrial, scientific, and medical (ISM) equipment as

> "Equipment or appliances designed to generate and use locally RF energy for industrial, scientific, medical, domestic or similar purposes, excluding applications in the field of telecommunication. Typical ISM applications are the production of physical, biological, or chemical effects such as heating, ionization of gases, mechanical vibrations, hair removal and acceleration of charged particles."[58]

59. Terahertz spectroscopy appears to be within the scope of the first sentence. However, it is not one of the "typical ISM applications" in the second sentence, which presumably is not binding. Present ISM applications are generally involved only with radio waves inducing heat in objects such as in microwave oven use.

60. We suggest that such rules limit terahertz spectroscopy to indoor uses and forbid marketing to the general public.[59] Such equipment should have a visible external label forbidding its use outdoors without an experimental license from FCC - or comparable NTIA authorization in the case of federal users. The rules should require all practicable approaches to shield radiation of main beam and scattered radiation from objects being tested from being radiated away from the operating equipment. The frequency range of this equipment should be 50-500 GHz and the maximum emitted power should be -30 dBm. During such a rulemaking these parameters can be refined in a dialogue with manufacturers and a Notice of Proposed Rulemaking should indicate an open minded approach to alternative parameters while focusing on protecting other active and passive spectrum users.

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[58] 47 C.F.R §18.107(c)

[59] In the early days of personal computers, Part 15 restricted marketing of "Class A digital devices" to only businesses. *See* UNDERSTANDING THE FCC REGULATIONS FOR COMPUTERS AND OTHER DIGITAL DEVICES, OET Bulletin 62, December 1993 at p. 3 (https://transition.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet62/oet62rev.pdf)

61. Another application of upper spectrum that we have recently become aware of is the MailSecur mail inspection technology[60] developed by RaySecur with technology transferred from the Canadian Space Agency. This system uses signals in the approximately 275-300 GHz band to examine sealed letters to see whether they might contain dangerous substances. The transmissions cover a range of inches and are generally captured within the device. It is an indoor system at a frequency range where building materials are rather opaque. Yet because of regulatory uncertainties sales of this safety-related product are being delayed.

62. As we mentioned earlier, FCC has not current or proposed quantitative RF safety limit above 100 GHz. The lack of such a limit also creates uncertainty for both the developers and future users of this equipment since users must be close to the small power source in the device.

63. A Part 18 addition for terahertz spectroscopy might be crafted to deal with both that technology and MailSecur-like inspection technology in order to let these technologies reach the market with appropriate safeguards but with minimal regulatory uncertainty

X. CONCLUSIONS

64. The spectrum above 95 GHz offers unique opportunities for both communications and non-communications uses of radio technology. While perhaps not as visible and not having the broad-based support of new spectrum for cellular and for Wi-Fi-like technology at this time, the use of this spectrum is not mutually exclusive with incumbents except possibly for passive users. However, these passive users can be protected through rules that take advantage of the physics of this spectrum, which is very different than the physics of lower bands, and that take advantage of spectrum sharing technique for satellites that have clear precedents in Part 25.

[60] http://raysecur.com/en/mailsecur A video of the system in operation is at https://youtu.be/Aj8WeQy7I-o?list=UUUHvfOFJIejQ7PZoqU8JaPw

65. It is ironic as we file these comments that the 41st International Conference on Infrared, Millimeter and Terahertz Waves[61] is ending in Copenhagen. A friend attending this meeting provided the following observations about the meeting and papers presented:

> "- one talk on a demonstration of a 50 Gbit/sec link at 320 GHz, 100 meter range (Japan)
> - one talk on a demonstration of QPSK and 16-QAM modulation for 60 Gbit/sec links at 290 GHz, 50 meter range (China)
> - one talk on a variety of links and modulations at up to 400 GHz (France)
>
> There is also considerable activity in Germany, UK, and Korea. I think, in all cases the funding for these projects come jointly from government and corporate sources (e.g., NTT jointly funds the Japanese project together with the relevant government ministry)."

66. The US' economic competitors are clearly targeting this upper part of the spectrum above all present FCC rules. The paper on a new 400 GHz terrestrial link that is the source of Figure 3 was supported the European Union's Horizon 2020 Research and Innovation Program.[62] Parallel funding from Asian countries is not so clearly identified but is almost certainly there. This type of state capitalism is *not* the US model for economic competitiveness. FCC's traditional policy is to rely on private sector initiative, but that will not work unless FCC policy above 95 GHz has full transparency and is responsive to requests from developers for rules to handle emerging technologies. Such responses need not be always positive, but they must be timely. The Commission may disagree with our view that § 7 requires a specific time schedule,

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[61] http://www.irmmw-thz2016.org/

[62] https://ec.europa.eu/programmes/horizon2020/en/what-horizon-2020

> "Seen as a means to drive economic growth and create jobs, Horizon 2020 has the political backing of Europe's leaders and the Members of the European Parliament. They agreed that research is an investment in our future and so put it at the heart of the EU's blueprint for smart, sustainable and inclusive growth and jobs.
>
> By coupling research and innovation, Horizon 2020 is helping to achieve this with its emphasis on excellent science, industrial leadership and tackling societal challenges. The goal is to ensure Europe produces world-class science, removes barriers to innovation and makes it easier for the public and private sectors to work together in delivering innovation."

but if so it should state what its expectation of response time is. It has done so for corporate mergers/"significant transaction" where there is no statutory time mandate comparable to § 7.[63] We urge at the very least a parallel guidance on how it will handle new technology requests above 95 GHz to maintain international competitiveness.

67. We urge the Commission to clarify its position on how § 7 applies to the bands above 95 GHz. This could be done by finally resolving the issues in Docket 13-259.

68. We urge the Commission to resolve the status of RM-11713 and allow access to the existing Fixed and Mobile coprimary allocation in 102-109.5 GHz.

69. We urge the Commission to take action in Docket 13-84 to extend quantitative RF safety limits above the present 100 GHz limit to at least 200 GHz to decrease regulatory uncertainty and avoid the possibility of local regulations that could not easily be preempted in a federal regulatory vacuum.

70. We urge the Commission to seriously consider the Spectrum Policy Task Force recommendation for *de novo* review before making licensed unlicensed decisions for spectrum above 95 GHz.

71. We urge the Commission to work with NTIA to improve interagency transparency in this spectrum consistent with the statutory charges of <u>both</u> agencies. In particular, we urge FCC to develop with NTIA a protection strategy for passive systems that results in sharing so that blocks of at least 20 GHz are available for terrestrial fixed services for certain situations where fiber optics is not viable.

72. Finally we urge the Commission to promptly initiate rulemaking to legitimize use of terahertz spectroscopy and related low power indoor use in the spectrum of 50 GHz to 500 GHz, possibly by adopting new Part 18 rules for such use with provisions that protect incumbent or

[63] https://www.fcc.gov/reports-research/guides/review-of-significant-transactions

future passive services consistent with the *basic intent* of RR 5.149, 5.340 and 5.585 as well as US 246 to effectively protect passive bands from harmful interference.

September 30, 2016

/S/

Michael J. Marcus, Sc.D., F-IEEE
Director
Marcus Spectrum Solutions LLC
Cabin John MD 20818

mjmarcus@marcus-spectrum.com

cc:

Comm. Pai
Comm. Rosenworcel
Johanna Thomas
Brendan Carr
Julius Knapp
Ira Keltz
Ron Repasi
Jamison Prime
Michael Ha
John Kennedy
Walter Johnston
James Schlichting
Charles Mathias
Diane Dupert
Michael Mullinix